

**Affordable Access to Space Using the Russian Dnepr Launch Vehicle:
*Twists and Turns in the Road to Export Approval and Launch***

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Abstract. The Russian Dnepr Launch Vehicle, available to U.S. companies through the launch services of International Space Company Kosmotras ("ISC Kosmotras"), provides flexible and affordable access to space for small satellites, but involves a number of legal, bureaucratic and logistic challenges. The launch of two LatinSat spacecraft in December 2002 from Baikonur Cosmodrome represents the first U.S.-manufactured microsatellites launched on a Russian military rocket. SpaceQuest has documented its experience in an effort to assist other U.S. companies as they weigh the benefits of a Dnepr launch against the daunting prospect of a lengthy and burdensome launch preparation process and the logistics of conducting a launch campaign from a remote launch base in Kazakhstan.

SpaceQuest's successful navigation through this complicated and time-consuming process provides insight into factors that a company must consider when deciding if a Dnepr launch is a viable option. This paper details the entire preparation process, the documents that need to be submitted, the required approvals, the costs associated with the various activities, and the launch campaign itself.

Introduction

SpaceQuest is a developer of advanced satellite technology for government, university and commercial use, specializing in the design, development, testing and manufacture of spacecraft as well as space and ground components for operation with low-Earth orbiting satellites. The company had been seeking a highly reliable, yet low-cost launch solution for launching its little LEO satellites. ISC Kosmotras was established in 1997 in the Russian Federation to convert SS-18 intercontinental ballistic missiles for use in civilian space launches. Because secondary or "piggyback" launch opportunities in low-Earth orbit are relatively rare, the availability of the Dnepr Launch Vehicles for small satellite "cluster" launches presented SpaceQuest with an

option that could dramatically reduce launch costs for its small spacecraft missions. The signing of a Launch Services Agreement with ISC Kosmotras marked the beginning of a two-year journey that would culminate in the successful launch of two LatinSat microsatellites. The following information is based on SpaceQuest's experience in preparing for a Dnepr launch. Every company has unique mission requirements that will affect their assessment of the capabilities, costs and time constraints of this option. Some of the particulars presented here may change from launch to launch, and not all of this material may be relevant to other participants. Nonetheless, it is hoped that this article can help as a decision-making tool or serve as a general guide for those who have already opted for a Dnepr launch.

U.S. Export Laws and Regulations

Satellites and associated equipment such as ground support equipment, test equipment, payload adapter or interface hardware are categorized as *defense articles* and as such are subject to strict U.S. government export regulation as well international agreements. Likewise, the exchange of information with a launch services provider is considered “technical defense information” and falls under the export laws and regulations that govern trade of defense articles, defense services and defense technical data. Section 38 of the *Arms Export Control Act* (22 U.S.C. 2778) (“AECA”) authorizes the President to control the export and import of defense articles and defense services. It is the purpose of the *International Traffic in Arms Regulations* (“ITAR”) to implement this authority.

The statutory authority of the President to put these regulations into operation was delegated to the Secretary of State by Executive Order 11958, as amended (42 FR 4311). *The Directorate of Defense Trade Controls, Bureau of Political-Military Affairs* (PM/DDTC) is the primary entity within the Department of State to administer the ITAR regulations.

AECA also provides that the President shall designate what items shall be deemed defense articles and defense services for purposes of ITAR. These designated items constitute the *United States Munitions List* (“USML”). By virtue of Presidential delegation, these designations are made by the Department of State with the concurrence of the Department of Defense. Commercial, scientific, experimental and research satellites that are not intended for use by the armed forces of a foreign country are considered “unclassified defense articles.” These satellites fall under USML category XV (a). Associated equipment, such as a portable test set used to perform end-to-end tests on the satellite communication electronics prior to mating the satellites to the Launch Vehicle, fall under the USML category XV (e).

The PM/DDTC also ensures that authorizations of exports take into account all U.S. bilateral and multilateral agreements related to arms transfers.

U.S. companies launching satellites from Baikonur, Kazakhstan must comply with the terms of the *Technology Safeguards Agreement between the U.S. Government and the Governments of Russia and Kazakhstan dated January 1999* and the *Technology Safeguards Agreement between the U.S. Government and the Government of Russia dated January 2000*, and U.S. Government measures for the implementation of these agreements. In addition, the *Dnepr Launch Vehicle is a START-1 accountable ICBM* and as such, the launch services provider must comply with all relevant international obligations relating to ICBM flight tests in the START-1 treaty.

Obtaining an Export License

Launching U.S.-origin small satellites on the Russian Dnepr Launch Vehicle is a lengthy process that requires substantial lead-time. For first time applicants, it would be advisable to start these activities at least 18 months prior to launch to accommodate the numerous procedural requirements and lengthy government review. The process requires two steps: Registration and Licensing.

Department of State Registration

Manufacturers and exporters of U.S. defense articles, services or technical data – in this case, satellites, related equipment and technical information related to launch services – must register with the Department of State, Directorate of Defense Trade Controls. It is a precondition to obtaining a license and approval to export. Registration is just an enrollment. Only exporters that have registered with DDTC may submit an export license application. The registration process provides information to the U.S. Government about who is involved in manufacturing and exporting activities and provides the necessary contact information for DDTC to inform companies on the latest relevant regulations and policies pertaining to their activities.

Registration Application Submission

The Registration Application consists of the following:

Statement of Registration

Form DS-2032 (replaces the old Form DSP-9) containing information about the nature and structure of your business and the USML category of the goods to be exported must be completed.

Letter of Transmittal

The Letter of Transmittal must be signed by an authorized senior officer of the company. The transmittal letter must include specific declarations according to the Code of Federal Regulations pertaining to whether registrant has been indicted or convicted of violating certain laws or is ineligible to receive a license.

Authorization Document

Three copies of a document that authorizes the applicant to do business in the U.S., such as a State Incorporation Certificate, State Certificate of Good Standing or State, Country or City Business License must be attached.

Registration Fee

The correct registration fee, made out to the Department of State is required. It is advisable to register for the maximum of four years to reduce the administrative burden, take advantage of fee savings and to accommodate a longer launch schedule, if anticipated. The price for one year registration is \$600. Four years is \$2200.

Assignment of Registration Number

Official Registration

A firm is officially registered with the Directorate of Defense Trade Controls when a Registration Number is assigned. A minimum of 2 weeks should be anticipated prior to assignment of a Registration Number.

Maintenance of Records by Registrants

Anyone who is required to register must maintain records for a period of five years after expiration of their license, concerning the manufacture, acquisition and disposition of *defense articles*, provision of defense services; and information on political contributions, fees or commissions

furnished or obtained. These records must be available for inspection by the Directorate of Defense Trade Controls.

Temporary Export License for Baikonur Launch Services

Unclassified commercial, scientific, experimental and research satellites that are launched from Baikonur Cosmodrome in Kazakhstan require a license for “Temporary Export of Unclassified Defense Articles.” This means that title to the articles will not be transferred, the articles will be exported for a period of less than 4 years, and will be returned to the United States. Russia and Kazakhstan are only temporary export destinations, as the satellites will ultimately be under U.S. control once they are launched. Once issued, a license is valid for 4 years. A new license application for Temporary Export of Unclassified Defense Articles consists of the following:

- 9 copies of *Form DSP-73*
- 7 sets of any descriptive literature of the satellites or equipment.
- 7 copies of any prior or “Precedent Approvals.”
- An original and 6 copies of a Letter of Explanation – optional but advised.
- A Technical Assistance Agreement (“TAA”) between the satellite exporter and the launch services provider, ISC Kosmotras, must be submitted for review and approval by the Department of State, Directorate of Defense Trade Controls before any technical data can be exchanged.
- A Technology Transfer Control Plan (“TCCP”) must be submitted for review and approval by the U.S. Department of Defense, Defense Technology Security Administration, Space Launch Monitoring Division (“DTSA”) before any technical data can be exchanged.
- All items comprising a full application submission must be collated. The package is then submitted to the Managing Director of the Directorate of Defense Trade Controls, U.S. Department of State in Washington, D.C.

The DSP-73 Application

Information provided on this form includes the type, model number and part number of commodities to be exported and quantities of each, the USML Category of the commodities, the value of the commodities (selling price), the satellite manufacturer and the specific purpose of the temporary export. For firms applying for export approval to participate in a Dnepr launch, the purpose entered would be to test and verify the functioning of the applicable satellite(s) followed by integration and launch on the Dnepr Launch Vehicle.

Shipment of items (spacecraft and related test equipment) must not exceed the total value listed during the period of license validity.

Spacecraft may be temporarily exported for launch at one time for a specific launch or at different times to accommodate a specific launch schedule that falls within the period that the license is valid.

The application form requests the name and address of the “foreign intermediate consignee” and “temporary foreign consignee.” As the microsatellites are hand-carried to the launch site, as described below, and never leave the control of U.S. personnel up to the time they are encapsulated and mated to the Launch Vehicle, the only “intermediate” or “temporary” consignee” is the company handling customs clearance at Sheremetyevo Airport in Moscow, which is the necessary intermediate stop prior to the flight to Baikonur. The most experienced customs clearance company for Baikonur satellite launches is *Express Service*, whose services are further described below.

The signatory to the application must be an “empowered official” who is authorized by the company to sign and attest to the truth of the statements in the application as well as certify that a number of conditions listed on the form have been met which would otherwise bar the applicant from receiving a license, such as ineligibility due to indictment, conviction or violation of U.S. criminal statutes related to the Arms Export Control Act.

The Technical Assistance Agreement

A TAA is required under U.S. Government regulations and may not enter into force until approved by the State Department. The TAA is independent of any Launch Services Agreement that may be entered into with ISC Kosmotras. The parties to the TAA agree to abide by all U.S. and international laws and regulations relating to the provision of defense services and technical data and allows for the exchange of technical data to enable ISC Kosmotras to develop a spacecraft-to-Launch Vehicle interface adapter as well as integrate the spacecraft to the Dnepr Launch Vehicle. The TAA includes a Statement of Work which outlines the scope of activities to be carried out by both parties to the TAA.

The Technology Transfer Control Plan

The TTCP covers technical data and know-how that is to be transferred during the contract between the exporter and ISC Kosmotras. It describes how ITAR controlled data will be monitored so that it is not released.

TTCP Requirements

The TTCP must address training procedures, security procedures, transportation procedures, work location procedures, monitoring procedures, procedures for logging and control of technical data and all meetings, visits, telephone and electronic exchange with foreign personnel, as well as a list of releasable data. The TTCP must address:

- The control of technical data in person-to-person interfaces with ISC Kosmotras;
- The extent and the level of technical data to be released or discussed with ISC Kosmotras;
- Administrative control processes for the technical data;
- Control of U.S. manufactured components.
- Procedures for DTSA Review

Non-Releasable Data.

Detailed engineering design data for the satellite, components (including radhard ICs), manufacturing and production processing or know-how may not be released. Satellite flight code or ground control source code, may not be released. A U.S. firm may not provide any technical assistance whatsoever to ISC Kosmotras which might assist them in the design, development, or enhancement of contemplated or existing space Launch Vehicles, missiles, launch facilities, or launch process/operations.

On-Going Monitoring by DoD

Technical meetings and launch related activities with the foreign launch service provider must have a DoD monitor present unless exempted by DTSA. Unless exempted, prior notification of all technical meetings and launch related activities with the foreign launch service provider must be given to DTSA in writing.

Copies of all ITAR controlled technical data that are planned for release to ISC Kosmotras must first be submitted to DTSA for approval.

Reimbursement of Costs to DoD

Exporters holding licenses that require monitoring by DoD are required to reimburse the DoD Space Launch Monitoring Program for the license holder's share of the costs for this Program. This reimbursement procedure is authorized by Public Law 105-261 and AECA. These costs may include salaries, travel, transportation, training, and communications, etc. The license holder will be required to sign a DoD reimbursement agreement indicating concurrence with these procedures. An assessment of estimated costs is made by DoD and sent to the license holder. There is then an opportunity for the license holder to provide comments before a final assessment is made. Small or microsatellite commercial, research or experimental missions normally require a minimum of supervision, and therefore the costs should be moderate.

Non-Disclosure Agreement

All U.S. employees and consultants engaged in the satellite program must sign a Non-Disclosure Agreement indicating that they have read the TTCP, have been briefed on U.S. laws, regulations and policies pertaining to the transfer and exchange of sensitive technical data, and will comply with the entire plan and all existing and future U.S. laws, regulations and policies pertaining to the transfer and exchange of such data. The employee also attests to his understanding that failure to comply could result in fine or imprisonment.

Russian nationals from ISC Kosmotras involved in the satellite program who will have access to the controlled defense articles approved for export and/or to whom approved technical data will be disclosed, must also sign a Non-Disclosure Agreement and attest to their understanding that U.S. and Russian laws and regulations provide for fines and imprisonment for willful non-compliance.

Transportation Logistics of Spacecraft and Special Equipment to Baikonur

The size of microsatellites makes it possible to hand-carry them to the launch site in Baikonur, Kazakhstan. The trip to Baikonur is routed via Moscow, where an overnight stay is likely. One advantage of traveling with the satellites is the added assurance that the payload will safely reach the launch point and, if necessary, be safely returned to the U.S. Transporting the satellite by hand also provides the opportunity to ensure that proper security and safety procedures are followed en-route and that customs clearance goes as smoothly as possible.

U.S. Assembly Facility to Embarkation Point

After the satellites are constructed and integrated at the U.S. facility, the satellites can be packed into a suitable small shipping container and then hand-carried to the U.S. airport embarkation point. The satellites may only leave from a point in the United States where a District Director of Customs is available, or from a U.S. Post Office (which

requires separate procedures not discussed here). The Temporary Export License must be presented to the customs official who will verify and endorse the exit column on the reverse side of the license. The endorsed license is retained by the licensee and returned to the Department of State when it expires or when the total value or quantity authorized has been shipped, whichever occurs first.



Fig. 1 Transport thru Dulles Airport

Embarkation Point to Russia

The satellites are hand-carried by U.S. personnel to Moscow on a commercial airline as personal baggage and stored on board with assistance from the flight crew. Prior coordination with the airline is advisable. In Moscow, the U.S. team is met by *Express Service* who assists in customs clearance at Sheremetyevo airport.

Express Service - Customs Clearance

Express Service is a major international freight forwarder and customs broker within Russia serving the aerospace industry. They also have a location at JFK Airport in New York. The company handles transportation and customs clearance operations for Dnepr launches as well as spacecraft delivery to Baikonur Cosmodrome. They also assist in the timely and correct preparation of accompanying documentation. It is

important to engage an experienced firm in this area to negotiate the intricacies of Russian regulation as well as to arrange onward travel to Baikonur, Kazakhstan.



Fig. 2 Storage on Commercial Airline

Space-related equipment arriving in Russia for onward transport to Baikonur, must be cleared through customs at Sheremetyevo Airport in Moscow and undergo x-ray examination as a security precaution. Special technology rules are applied to the temporary import of space-related equipment which must satisfy the requirements of Russian customs rules and which are approved by the State Customs Committee of the Russian Federation jointly with the Russia Space Agency. Sheremetyevo airport is the port of entry and the port of departure for Baikonur launches. This means that all satellites arriving in Russia through Sheremetyevo must leave Russia through the same airport.

Once cleared through customs, the only choices for onward travel to Baikonur are through another airport outside of Moscow, Vnukova Airport, or by charter flight arranged by Express Service and leaving from the domestic terminal at Sheremetyevo Airport. Traveling via Vnukova Airport with satellites in tow is problematic for several reasons. Firstly, there are only two flights per week out of Vnukova Airport to Baikonur. Secondly, because the airport of departure in Russia must be under the jurisdiction of the customs house where clearance is going to be done, only Sheremetyevo Airport can be used as the point of departure to Kazakhstan, although Express Service is willing to explore the feasibility of travel through Vnukova. A third possibility

may exist for Express Service to arrange through transit all the way to Baikonur, without payment of customs duties in Moscow. However, Express Service states that this is a significantly more expensive option as customs duties upon arrival in Baikonur would amount to 55% of the value of the goods.

Express-Service highly recommends traveling to Baikonur by charter where the other participants in the cluster launch can arrange to arrive in Moscow on the same day and then share the cost of a charter flight. This has proven to be an effective way to travel for SpaceQuest as it allows SpaceQuest personnel to maintain control of the satellites and related equipment at all times. The total charter price can range from US\$20,000 to \$25,000. The individual company cost will depend on the number of participants. As returning travelers will not be carrying the spacecraft home, the return from Baikonur can be booked on a commercial flight through Vnukova Airport.

SpaceQuest's decision to go through customs in Moscow, and then continue onward to Baikonur via charter airline, resulted in total costs for customs services, duties and clearance fees of approximately 10% of the value of the satellites and equipment. Companies with low-cost payloads particularly should not find these costs prohibitive because of the total cost savings of the mission using the Dnepr Launch Vehicle. Fees are determined in advance and wire-transferred to Express-Service, prior to equipment arrival in Moscow.



Fig. 3 Meeting with Kosmotras Project Manager at Novotel Hotel

Due to the logistics involved, an overnight stay in Moscow will be likely prior to departure for Baikonur by charter flight. The Novotel Sheremetyevo-2 Hotel is a modern, convenient hotel close to the airport and is recommended. Approximate prices in 2002 were US\$150 for a single room and US\$180 for a double room by booking on-line. Higher prices usually apply for booking direct (US\$182-\$222). Free shuttle bus service is available between the hotel and Sheremetyevo Airport.

Upon arrival in Baikonur, hotel accommodations at the Sputnik hotel are recommended. It was built several years ago to elevated western standards for foreign customers and technicians. Rates are approximately \$190.00 per night including breakfast. There are less expensive hotels in Baikonur, but the facilities are modest at best. Payment in full is made by wire transfer prior to arrival to a bank in Portugal. Hotel policy states that the money will be refunded for cancellation of the reservations. After arrival, all extra charges such as meals, packaged lunches, telephone, etc. are to be paid in cash because credit cards are not accepted.



Fig. 4 Sputnik Hotel in Baikonur, Kazakhstan

ISC Kosmotras can perform some of the services listed above for a fee. These services include hotel reservations in Moscow and Baikonur, transfers in Moscow and Baikonur, reservation and buying tickets from Moscow to Baikonur and from Baikonur to Moscow, and meal arrangements. It has been SpaceQuest's personal experience that these requirements can easily and less expensively be accomplished without ISC Kosmotras assistance. However, it is recommended that at a minimum travelers engage ISC Kosmotras for visa support and for obtaining Baikonur Cosmodrome Access clearance.

Visa Processing and Baikonur Clearance

Visa Processing

Official Invitation

Visa issuance procedure is the responsibility of ISC Kosmotras as an official invitation from the Russian Ministry of Foreign Affairs will have to be issued in order to obtain a visa. ISC Kosmotras will require information on the visiting specialists as well as an official request of the customer to ISC Kosmotras on company letterhead containing the purpose of the visit to Russia and Baikonur Cosmodrome. ISC Kosmotras will send the official invitation required to obtain the Russian entry visa to the relevant Russian Consulate for each traveler or directly to the company.

Multiple Entry Business Visa

For entry into Moscow, Russia and Baikonur, Kazakhstan a multiple entry Russian visa is required. A visa application must be submitted to the Consular Section of the Russian Embassy. The Russian Federation maintains Consular Offices in four locations in the U.S., with each having its own jurisdiction. To obtain a business visa, the following documents must be submitted to your local Russian Consulate:

- Completed visa application form
- Passport size photo stapled in the designated upper right hand corner
- A valid passport expiring no less than one month after departure date, with at least one blank page for the visa
- Official Letter of Invitation from Russian Ministry of Foreign Affairs that was received from ISC Kosmotras
- A letter from the company on company letterhead, giving information about the travelers, destination, terms and purpose of the trip
- Supplemental application form – This is an additional form that was introduced in 2002 to mirror a similar requirement by the US Consular Service for Russian citizens. It requires US male citizens age 16 to 45 seeking a Russian entry visa to provide such

information as their military service, participation in the military conflicts, college degree, employer history and a list of countries visited in the last 10 years.

- A self-addressed stamped return envelope must be included with the package if applying by mail.
- The cost of a multiple entry visa is \$200 for 3+ days processing; \$350 for next-day or 2 day processing and \$450 for same day processing. Visa processing fee is non-refundable.

Strict Adherence to Visa Application Procedure

It should be noted that the visa application procedure must be followed exactly and all information must be submitted before review or consideration of any request for a visa.

Baikonur Cosmodrome Clearance

The Baikonur Facility

The Baikonur Cosmodrome is located approximately 1,300 miles southeast of Moscow, in the former Soviet republic of Kazakhstan. The first artificial satellite, Sputnik 1, and first human in space, Yuri Gagarin, were launched from Baikonur. All subsequent Russian manned missions have lifted off from there, as well as geostationary, lunar, planetary, and many ocean surveillance missions. Baikonur is leased to the Russians by Kazakhstan. Baikonur's once top-secret space flight center is now a center for Russian commercial space flight and supports the largest range of Launch Vehicles of the former Soviet Union. It is the location of the Dnepr Space Launch System. ISC Kosmotras was established to convert and launch former Soviet SS-18 ballistic missiles as Dnepr Launch Vehicles for commercial payloads.

Restricted Access

Baikonur Cosmodrome has the status of a Russian federal space center and access to the center is restricted. The infrastructure and facilities of the Dnepr Space Launch System at Baikonur are under the supervision of the Russian Aerospace Agency and Russian Ministry of Defense.

It is the responsibility of ISC Kosmotras to obtain access clearance for its customers from Russian

federal authorities. For this purpose it will be necessary for launch customers to provide ISC Kosmotras with the names, date of birth, passport information and citizenship of all planned visitors to Baikonur Cosmodrome.



Fig. 5 Entrance to Launch Integration Facility

All visitors will be issued identification badges, coordinated with ISC Kosmotras security and only those personnel submitted to ISC Kosmotras prior to the launch will be allowed access to the launch integration facility and the launch viewing area.

Payload Monitoring and Security Through Transportation and Launch

U.S. manufactured spacecraft are space-related items that are controlled under the ITAR. All ITAR-controlled space-related items must be secured and/or monitored continuously, and must not be released to the Russian launch services provider prior to fairing closeout. The primary purpose of mission security is to safeguard the ITAR restricted items from uncontrolled examination or theft, especially while outside of the U.S. Payload monitoring must include the following phases of activity:

- The manufacturing and integration facilities in the U.S. must be secured at all times.
- The satellites must be accompanied by DoD personnel when being transported to the launch site unless a waiver is granted by PM/DDTC, in which case the satellites are continuously monitored by designated U.S. company personnel.
- The satellites must be secured and sealed prior to overseas transit and are to be accompanied and monitored by U.S. company personnel during overseas transit.
- When the satellites arrive at their first point of call in Russia until they are either launched or sealed for shipment back to the U.S. they must be monitored continuously to guard against access by foreign persons.

U.S. Assembly Facility to Embarkation Point

The satellites to be exported for launch on the Dnepr Launch Vehicle are constructed and integrated at the U.S. company's manufacturing facility. Upon completion of functional testing, the satellites are packed in small shipping containers (SpaceQuest shipping containers measured approximately 12" x 15" x 15"). The satellites are then transported to the embarkation point at the nearest international airport by the U.S. company personnel.

Embarkation Point to Russia

SpaceQuest has arranged for special security inspection and clearance for its spacecraft and equipment at Dulles International Airport and is given VIP security screening prior to departure.

The satellites are hand-carried by U.S. company personnel to Moscow on a commercial airline as personal baggage. The shipping containers are carried on board the airplane and stored behind the seat during flight. As mentioned earlier, it is advisable to coordinate and clear with airline personnel in advance so that they are aware of the nature, size and type of goods being brought on-board and stored on the aircraft during flight.

The spacecraft are then hand-carried as personal baggage through customs in Moscow, with the assistance of Express Service. They are then carried to a local hotel where they remain overnight under the control of U.S. personnel.

First-point-of-call to Baikonur Facility

The following morning, the satellites, still in their shipping containers, are returned to the Moscow airport. Transportation from Moscow to the Baikonur Cosmodrome in Kazakhstan is by a private chartered airline.



Fig. 6 Charter Flight to Baikonur Cosmodrome

Upon arrival at the airport in Baikonur the satellites are transported by U.S. company personnel to the local hotel where they remain in the custody of U.S. company personnel until they are transported to the launch site, prepared for launch, and mated to the Dnepr Launch Vehicle.

Ground Support Electronics

Ground support equipment consists of an earth station simulator, tools, test instruments, solar panels, antennas, laptop computer, or anything else required to prepare the spacecraft for flight. The equipment should be able to perform an end-to-end test on the satellite communication electronics prior to mating the satellites to the Dnepr Launch Vehicle. The ground support electronics are carried as hand baggage by U.S. company personnel via commercial air to the Baikonur Cosmodrome along with the spacecraft.

Return to United States

Once the satellites have been launched, the ground support electronics packed in the aluminum carrying case are immediately returned to the United States hand carried by U.S. company personnel via commercial air.

In the unlikely event that the spacecraft must be returned to the United States, they are to be repacked in their original shipping containers and hand carried by U.S. company personnel via commercial airlines to Moscow and then back to the U.S. The spacecraft containers must be sealed and must not leave the control of U.S. company personnel until they arrive at their final destination in the United States.

Spacecraft Integration Activities

The satellites and launch integration team must arrive at the launch base at least 20 days prior to the scheduled launch date. All spacecraft preparation activities and mating to the Dnepr Space Head must be completed 10 days prior to the launch. Following integration with the space head, the satellite payloads are encapsulated and sealed prior to being transported to the Space Head processing facility and then to the launch silo to be mated with the rocket. Once the satellites are sealed inside the Payload Encapsulated Module (PLEM), responsibility is transferred from the spacecraft owner to ISC Kosmotras, and continuous monitoring is no longer required unless the PLEM is returned to the clean room and opened in the event of a problem.



Fig. 7 Spacecraft Integrated to Dnepr Space Head

Required Documentation

Customer's responsibility

Transportation

Customer is responsible for suitable transport, customs procedures and duties as well as required documentation for transporting Spacecraft, ground support equipment and associated Customer's Personnel to and from its country and launch base airport.

Documentation Provided to ISC Kosmotras

Customer is responsible for the supply of the following documentation to ISC Kosmotras by no later than 6 months before beginning of the launch period (except for paragraph (ix.):

- Spacecraft purpose and basic specifications;
- Spacecraft mechanical environmental test results;
- Spacecraft safety document to include information on their fire-safety and explosion proofness;
- Statement that the Spacecraft will not be for military purposes from the appropriate government organization in the country where ownership will reside after the satellite is placed into orbit;
- Written statement from the appropriate government organization in the country where ownership will reside after the Spacecraft are placed into orbit stating that the Spacecraft to be launched by the Dnepr Launch Vehicle will be registered in the national register of space objects. For ownership in United States, the official U.S. Registry of Space Objects Launched into Outer Space is maintained by the Space and Advanced Technology (SAT) Staff, which is located within the Department of State's Bureau of Oceans and International Environmental and Scientific Affairs.
- List of Equipment temporarily imported by Customer for the launch, its mass and dimensional characteristics and its cost.
- Document on Spacecraft radio frequency bands and maximum levels of UHF emission;

- Spacecraft owner's document on the insurance details;
- Spacecraft launch clearance document - Responsibility Change Act (after Spacecraft integration to the Launch Vehicle payload adapter).



Fig. 8 Executing Launch Clearance Document

Responsibility of ISC Kosmotras

The Interface Control Document (ICD) including launch preparation and launch schedule. Customer will provide the necessary input to generate the ICD. The ICD will govern the technical interface between Spacecraft and the Launch Vehicle and is the sole document for the technical interface between the Spacecraft and the Launch Vehicle. The ICD is continuously updated until the launch is performed.



Fig. 9 Dnepr Payload Encapsulation Module

Official report on ground test results, including fit-check, vibration and separation tests using dummies of Spacecraft mass. The ground tests are performed by Design Bureau DB Yuzhnoye at Dnepropetrovsk, Ukraine. DB Yuzhnoye is part of the cooperative venture between the Russian Federation, the Ukraine and Kazakhstan for the Dnepr Launch Program. It is the primary design and development organization for the Launch Vehicle and the entire Dnepr Space Launch System.

Document confirming the separation of Spacecraft and Launch Vehicle based on telemetry data (5 hours after launch);

Preliminary information about flight parameters of Spacecraft 24 hours following separation. The list of flight parameters is contained in the ICD.

Other Information

Customer, if required, shall provide draft text information to ISC Kosmotras to be painted on the Launch Vehicle fairing;

ISC Kosmotras, when preparing the Launch Vehicle for launch, will paint the Customer provided information on the Launch Vehicle fairing;

ISC Kosmotras will provide opportunities for Customer to photograph the Launch Vehicle fairing, or provide photographs.



Fig. 10 Ejection of Dnepr Fairing

Launch Integration Timeline

Planning activities for launching a US-manufactured satellite on a Russian Dnepr Launch Vehicle should begin at least 18 months prior to launch. A typical timeline of the critical activities is shown in the table below:

Critical Activities Timeline	
Activity	Time Prior to Launch
State Dept Registration	18+ months
Apply for Export License	18 months
Sign Launch Services Agreement, subject to receipt of Export License	12 months
Receive License with Provisos	8 months
Respond to Provisos and Receive Final Approval	6 months
Provide Technical Data and required documents to ISC Kosmotras	6 months
Arrange details for Spacecraft delivery and customs clearance to Russia and Kazakhstan	3 months
Visa and Clearance Processing	3 months
Receive Invitation Letter and Apply for Visa	2 months
Satellites and Launch Integration Team arrive at Baikonur Cosmodrome	20 days
Spacecraft preparation complete and mated to the Dnepr Space Head	10 days
Dnepr preparation for launch	7 days
Delegations and launch observers arrive in Baikonur	1-2 days
Dnepr launch	Launch Day
Preparation for departure	Next day or per twice weekly flight schedule

Conclusion

Riding “piggyback” alongside larger primary payloads can provide cost-effective access into orbit for small satellites as the major launch cost is recovered from the primary payload.

Taking this route, however, may either be too restrictive for some satellite launches or the preparatory process too discouraging because of its exhaustive and time-consuming nature.

It has been SpaceQuest’s experience that despite the time and effort required to accomplish these tasks, the Dnepr Launch Vehicle still represents the lowest cost, most flexible, quickest, and most convenient access to space for small and micro spacecraft.

Disclaimer

The information presented in this paper is based solely on reference materials gathered by the author and the direct experience of SpaceQuest in the export approval and launch preparation process. This paper does not represent any type of official position, process, or policy of the U.S. Department of State, the U.S. Department of Defense, any agency of the U.S. government, or any other corporation.

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Fig. 11 Silo Launch of Dnepr Rocket

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Biography

Dr. Dino A. Lorenzini has over thirty years of experience in the development and management of complex space systems. During his career as an officer in the U.S. Air Force, Colonel Lorenzini held management responsibilities for several major space development projects, including the Apollo Lunar Module, the Peacekeeper Missile Guidance and Control System, the Navstar Global Positioning System, the High Energy Space Based Laser, and the Strategic Defense Initiative System Architecture.

As Director of the Strategic Defense Pilot Architecture Study Dr. Lorenzini led the technical efforts of over 75 leading scientists and engineers in the conceptual design and analysis of a National Ballistic Missile Defense System.

Dr. Lorenzini was the Founder and President of EYETEL International, the very first low-Earth orbit satellite system for worldwide asset tracking and environmental monitoring, where he guided the project's concept formulation, licensing, funding, development and operation. He also conceived the initial technical design for the Ellipso mobile satellite voice system.

Dr. Lorenzini is currently the President and CEO of SpaceQuest, Ltd., a provider of microsatellite components and busses, and Aprize Satellite Inc., a provider of low-Earth orbit satellite data relay services.

Dr. Lorenzini received his Ph.D. and M.S. degrees in Astronautical Engineering from the Massachusetts Institute of Technology. He earned an MBA in Business and Executive Management from Auburn University in Alabama.